DOCUMENT RESUME

ED 129 581 SE 020 950

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TITLE Precollege Marine Science Education 1973 Through 1976.
PUB DATE 76
NOTE 39p.

EDRS PRICE MF-$0.83 HC-$2.06 Plus Postage.
DESCRIPTORS *Bibliographies; Curriculum; *Educational Programs; *Elementary Education; Elementary School Science; Instruction; *Literature Reviews; *Oceanology; Science Education; *Secondary Education; Secondary School Science
IDENTIFIERS *Marine Science

ABSTRACT

A search of the literature on marine science education from 1973 through 1976 is presented. The major abstracting services were searched for January 1973 through February 1976 using the various marine science descriptors. In all, 67 articles were located which in some way were related to precollege marine science instruction. The largest category of literature contained articles on marine science programs; most of these were designed for infusion into already existing programs. Most of the program activity was located from Delaware south on the east coast and along the west coast, especially in California. (Author/MA)

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Precollege Marine Science Education

1973 Through 1976

by

Richard M. Schlenker

SE 020 950

Abstract

The major abstracting services were searched for the January 1973 through February 1976 period using the various marine science descriptors. In all, 67 articles were located which in some way were related to precollege marine science instruction. The largest category of literature contained articles describing marine science programs. The majority of these programs were designed for infusion into an already existing program. Program development was funded by local sources, the National Sea Grant Act and the Elementary Secondary School Act. The majority of the program activity took place from Delaware south on the east coast and along the west coast, especially in California.

Introduction

The United States enjoys more than 88,000 miles of coastline which is shared among 25 states. Situated along these coasts are some of the nation's most sparsely populated areas. These areas, both sparse and dense, have been the center of much recent public debate. The debate has raged between industry and the public and at times has involved various governmental organizations. At times debates have even flared within these various groups. How did all of this discourse come to pass and what does it all mean?

Suppose you were to awaken some morning to newspaper headlines which read, "Occidental Oil to Build Refinery in Our Town" or were to hear on the eight o'clock news that your town had been chosen as a proposed site of a new nuclear power plant, how would you react? What would be your reaction if you suddenly discovered that, in a harbor where you moored your pleasure boat, there had been a 100,000 barrel oil spill? In the past few years, many Americans have been faced with questions such as these. The way in which you would answer these questions no doubt seems quite vivid; however, what solutions would you have for the long term problems and what would you need to know in order to make literate judgements concerning these problems. The problems

of reasonable solution will probably appear orders of magnitude greater when you consider that any reasonable solutions must be such that they are of the greatest benefit to all of society, while not causing any undue stress on the environment. The search for answers to these dilemmas has spurred debate among all segments of society, most of which, at this point, is a matter of public record.

As a result of these issues, people were often called upon to make decisions concerning matters that, by virtue of their lack of educational background, they were unequipped to make. Many people, who were so unequipped, began to question what abilities their children might have, should they be faced with solving similar problems in the future. The answer seemed obvious, the future generation would be in the same predicament as their parents had been in unless some changes were made, and the obvious place to make changes was in the public school curricula. Thus there arose in many communities, a demand to educate future citizens to a point of scientific literacy in the marine sciences.

Educating children, to the point of scientific literacy in a given academic area, is a simple task for a teacher with a well rounded backgroumd in that area; however, what results could be expected of science teachers with little or no background in the marine sciences? The answer, of course, is that at best they would produce a poor product, but then teachers

are a resourceful lot. Many attended National Science Foundation summer institutes and inservice workshops in an effort to gain some expertise in these areas. Others had to rely on different sources in order to obtain the necessary expertise; what options were available? The option chosen quite rapidly by many was to seek out revelent articles in the literature and assimilate the useful knowledge and techniques into their already large repertoire of existent abilities, but again problems surfaced.

Many science teachers, although they were members of one of the national professional organizations and received the organizations periodicals, did not have access to one or more of the abstracting services such as Education Index, Current Index to Journals in Education etc. As a consequence, unless new articles in periodicals other than those normally received, were specifically pointed out they were quite often missed. As an attempt to partially rectify this situation, Readers Guide to Periodical Literature, Education Index, Current Index to Journals in Education and Educational Resources Information Center (ERIC) have been abstracted for the period in question using the various marine science descriptors. In the following context, survey and analytical reviews are presented of those articles which met the basic criterion for inclusion. That criterion was that the article was in some way either related to or useful in precollege marine science education.

Survey

Searching the abstracting services produced a bibliography of 67 articles published between January of 1973 and February of 1976 which met the basic criterion for inclusion. These articles fell into the following four general categories, (1) the state of the art in marine sciences, (2) information acquisition sources, (3) classroom and laboratory activities, (4) marine science education programs. Of this group, the fourth category was by far the largest. Each category is treated generally in the following discussion; however, each paper falling in a given category will not necessarily be cited. The fourth category is generally discussed in this section and then is the major subject of the analytical section. The order of discussion of the subject headings should not be interpreted as an order of importance; each enjoys equal status.

The State of the Art in Marine Sciences. As the reader no doubt realizes, this is a catchall category and might realistically include all articles published during the inclusive time period. In any event, the articles included herein should give the reader an idea not only of what is happening in marine science education but also an overview of some national and international events in the marine sciences.

Ever present in the national news is the question of who owns the sea. The literature is replete with discussions on the subject. Our past and present military leaders

have argued for strong naval forces in order that the sea-lanes might be kept open to multinational merchant use. Still vivid in the memories of many Americans is the challenge which Hitler's U-Boat forces made to free use of the sea-lanes in the 1940s.

With slow but continuous depletion of many of the world's natural resources, nations have increasingly turned to the sea and the seabed as a source of supply. This, along with the seeming disappearance of many commercial fish species, through over fishing, has forced nations to grapple with the question of who owns what. Earney (1975) points out that the United States set its' initial precendent, concerning control of the sea and the seabed beyond the inshore areas, in the Truman Proclamation of 1945. The Proclamation declared that the United States had jurisdiction over all of the contiguous continental shelf seaward to the 600-foot isobath. Although 31 years have passed since Truman's Proclamation, the U. S., as well as the rest of the world, have not been silent on the ocean issue. This is adequately pointed out by the Office of the President (1973), Knauss (1974), McDougal (1975), and Earney (1975). The U. S. Congress is currently debating the wisdom of declaring all waters within 200 miles of U. S. shores to be under U. S. jurisdiction.

In the earlier days of the marine sciences, the marine world was divided into several discrete subject areas, and investigators spent most if not all of their time working

in a single discrete area. As Marshall (1973) points out, the artificial barriers are now rapidly disappearing and the disciplines formerly known as marine chemistry, physical oceanography, marine biology etc. are rapidly becoming integrated into one unified discipline, know as Marine Science.

While the movement toward a unified Marine Science has probably presented no real problems to the practicing scientist, it has caused marine science educators to question what ought to be offered in precollege marine science programs and what priority of importance these offerings should enjoy. Awkerman, Teller and Laurie (1974) attempted to answer these questions by surveying 150 practing marine scientists via questionnaire. The questionnaire listed 40 marine science questions which the scientists were asked to rank order according to importance. The respondents were told that the order they gave to the items would indicate the order of importance these areas should have in a precollege marine science program. The data were pooled and tabulated using a priority index formula which assigned numerical values of between plus and minus one to the items. The questions were then ordered according to priority. This process identified the following questions as enjoying the top seven slots on the list.

1. Where do we find life in the sea?
2. Why is the continental shelf so productive?
3. What kinds of animals do we find in the sea?
4. How much food can we get from the sea?

5. How does the sea affect the worlds weather?

6. How is the ocean important to man?

7. How does the sun affect the sea?

In 1971, James P. Schweitzer of Louisiana State University started a data gathering task in an effort to determine how the nation stood in marine science education. Schweitzer (1973a) discusses the results of the survey efforts mentioned above. He had 400 respondents to his questionnaire, all of whom were identified as marine science educators. These educators were spread among 30 states and had approximately 20,000 students. Amongst other information, the questionnaire yielded the following numbers of marine science programs by grade level, information:

Grade Level	Number of Programs
7	103
8	112
9	139
10	310
11	442
12	473

This questionnaire also provided the information for Schweitzer's (1973b) publication.

While statements like, "state of the art" are perhaps nebulus with their definitions lying only in the mind of the definer, the reader no doubt at this point has some feeling for current directions in the marine sciences.

Information Acquisition. Perhaps one of the most time

consuming tasks, when one attempts to design his own science program, is that of acquiring a suitable bibliography. Regardless of the difficulty however, suitable bibliographies of films, books, and journal articles will be most important if an adequate program is to be constructed.

The task of acquiring a suitable bibliography becomes more difficult if it is to be used by students, since, in order to be used to greatest advantage, each publication or article must have its' reading level determined. This is especially important if the bibliography is to be used by pre-high students. Hemenway (1974) compiled a bibliography of 72 books useable with grades 1-9. Each entry in Hemenway's bibliography has had its' reading level determined. The reading level and a brief description are included immediately following each citation. Schweitzer (1973C) compiled a bibliography of marine science books which are reported to be useable in grades K-12.

Ring (1974) should be consulted by those desiring to use films as a complement to other forms of instructions. This publication is available free of cost from the author at the following address:

Cooperative Extension Service
University of Maine Marine Laboratory
Walpole, Maine 04573

When time is at a premium, program developers should consider adapting one of the already developed curriculum guides for use in their situation. Morgan (1974) compiled a list

of 40 such guides. These guides span the grade level spectrum from K-12.

One of the best methods of obtaining useful information is to converse with someone who has experience in your area of interest. This is essentially what Schweitzer (1973b mentioned above) had in mind when this directory was written. His purpose was to put together a list of names and addresses of practicing marine science educators so that these people would be able to correspond with one another and share information, experiences, and materials. Aside from the listing of the educator's addresses, the duration of each educator's course, grade level, number of classes per week, and total enrollment are included.

Other bibliographical information is available from various publishers, government agencies and from time to time, the literature. In the case of books however, the reading level is seldom if ever included. Some of these listings are to be found in the more recent issues of Sea Frontiers.

Classroom and Laboratory Activities. Some of the articles chosen to be included in this section are as applicable to aquatic as they are to marine situations. In a few instances the article was written specifically for the aquatic environment but the methods used are equally applicable to the marine world. This is especially true where methods of biological

material collection are involved. Mathis (1974) methods of investigating sulfur dioxide effects on lichens could be used in studying the terrestrial as well as the marine environment.

Rillo (1974) discusses oil pollution and all of its' ramifications. He pays close attention to the sequence of events which occur as the time between spill and cleanup increases. Contemporary cleanup methods and their shortcomings are also discussed at great length. In the learning activities section, 22 student activities are provided which can be used to investigate the effects of oil pollution and oil spill cleanup methods. Each of these activities has been graded by the author; however, they are probably useable with adult age individuals as well as younger people.

Mouvic (1973), Kane (1972), and Miller and Mazur (1974) offer interesting and simple methods of building and maintaining classroom aquaria at a minimum cost. These authors discuss the chemistry involved in maintaining purification in a closed system. Miller and Mazur (1974) suggest maintaining aquarium temperature below an unacceptable level by placing the aquarium of the gallon jar variety in a partially filled bucket of water. The temperature should be monitoried and ice cubes should be added to the water periodically.

Wright (1975), Lynch and Fenwick (1974), Marcus (1974), Postiglione (1975), Campbell (1975), Bruce and Linden (1973), Gregson (1973), Bryan (1974), and Murphy (1973 + 1974) have provided information and methods of studying physiological

and ecological aspects of various botanical and zoological organisms. Discussions of commercial uses of marine weeds, methods of collecting weeds and food pyramids are also included in these articles.

Gehring's (1973) students, although a hundred miles from the ocean, were able to study tidal cycles by using daily newspapers, East Coast Tide Tables and other periodicals.

Organisms may be collected for laboratory and classroom use in a variety of ways. As was previously mentioned, these methods can be used in both marine and aquatic situations. Hammer (1974) describes these methods.

A review of these and other articles of these types will provide much useful information to the instructor or school system, in the process of developing their own marine science program. There are however, some obvious gaps in the activity spectrum. These voids may be filled by, (1) adapting methods currently used in college study, to precollege use, (2) corresponding and sharing information with others involved in marine science education, (3) designing your own activities from the ground up.

Marine Science Education Programs. The literature describing marine science programs is another apposite source of available and useful information, especially for those just beginning to design these types of programs. These programs may be segregated in a host of ways. For example, they may be subdivided based upon, (1) their being actual programs which have already been tried or simply curriculum

guides which may be untried, (2) whether they are year long courses or mini-courses designed for curriculum infusion, (3) their subject matter content, (4) whether they are designed for elementary, junior high, senior high or K-12 etc.

One of word of caution, since the physical and biological parameters change as the geographical location changes, you should expect the program design to change somewhat as the location changes. For example, the species composition, tidal cycles, and shoreline morphology along the New England Coast differ greatly from the Florida Coast. These differences in characteristics, in many cases, necessitate the development of area specific programs. When reviewing the literature in this area, you should expect to find a certain amount of this area specificity, a fact to consider if you are purchasing curriculum guides. If at all possible, it is recommended that an analysis and evaluation be made prior to materials acquisition.

These programs are considered in greater detail in the Analysis section.

Analysis

By far, the largest single class of literature published between January 1973 and February 1976 described marine science education programs. These programs spanned the spectrum from kindergarten to grade 12. Some were developed

locally without outside financial support, some were developed locally with the support of either Title 1 or III of the Elementary Secondary Education Act and one was developed with the support of National Sea Grant Act funds. If there is a common thread which binds the majority of these programs together, it is that they are in some way activity based. The literature was easily subcategorized into two major groups, (1) programs either in operation at the time the article was published or programs which had been previously run, (2) published curriculum guides.

Marine Programs, Past and Present. For many years science educators have urged and prodded toward and expounded upon the wisdoms of an integrated K-12 science program. To a large extent, their crys have gone unheeded by school administrators and public alike. Where there are system wide coordinators, it is now not uncommon to find the same K-6 programs used by all elementary schools in the system. In systems, school administrative districts and school unions where there is a general lack of administrative coordination, we would at best expect to find the same program or graded series being used throughout a given school. Integrated K-12 science programs are few and far between. What does this all mean to the marine science educator and marine science education programs?

Marine science instruction in the senior high school

would be expected to take on three forms. First of all, it could be expected that full year upper level courses would be offered, with more basic courses acting as prerequisites. Second, full year courses without prerequisites might be found, and finally we would expect to find short or mini-courses designed for infusion into already existing science programs.

Marine science instruction at the junior high school level would most likely be infused into the existing science program, perhaps as a spinoff of an earth science course.

Science instruction in the elementary schools enjoys only a small portion of the total curriculum. Marine science instruction at this level, if it were found at all, would be expected to be only a small part of the total science program. Let us examine how these expectations compare with reality.

Perhaps the most interesting program in our collection and the only program funded by the National Sea Grant Act was reported by a staff author of Science Teacher (1975). This program was developed by the University of Delaware for export to the public schools. The most exciting aspects of this program are that it was designed for use in grades K-12 and embraces all of the curriculum areas. In the elementary grades, this program could be used as a total curriculum package. The program offers much for grades 7-12 study; however, realistically speaking, while the program does go a long way toward covering all of the subject areas,

there are some deficiencies. What this all means is that schools in coastal communities, at least in the elementary domain, can offer a program which is totally related to the children's everyday surroundings. It should however, be remembered that a good deal of work is required if a school desired to implement this program. In any event, the current total program cost is approximately $153.00. Those desiring additional information should contact:

Dr. Caroln Thoroughgood
313 Robinson Hall
University of Delaware
Newark, Delaware 19711

McFadden (1973) surveys programs in Charleston, Oregon, Poulsbo, Washington, Bellevue, Washington, Everett, Washington, Edmonds, Washington, Santa Ana, California, Santa Barbara, California and La Jolla, California. One of these programs is conducted only for grades 2, 4, and 6. Three are conducted in the junior and senior high only while the remainder provide instruction for some portion of the elementary school as well as the high school. Each of these programs involves a field trip to a marine station. The programs at Charleston, Poulsbo, Edmonds, Santa Barbara and La Jolla were designed and are essentially operated by a marine science station or institute of some description. While it is impossible to determine the amount of pretrip and post-trip classroom study that takes place with any one of these programs, the author implies that the field studies are only a portion of the total program.

Anson (1973), Cleveland (1973), Eyster (1975), Gee (1975), and Watling and Hallard (1974) describe programs in the elementary and junior high schools. Gee (1975) describes an activity based traveling program specifically designed for schools somewhat removed from the sea. In Gee's program, traveling instructors take the program, with its' associated equipment, to schools upon request. Once the equipment is set up in the classroom, students move through a series of stations performing hands on activities. Among others, these activities include the disection of herring.

Anson, Cleveland, and Watling and Hallard all report programs that include field trips. Anson (1973) describes the pretrip activities of a fifth grade program and Cleveland (1973) describes a first grade program, whose pretrip activities included vocabulary development and marine art lessons. The first graders then took a trip to a fish hatchery, where they watched the removal of eggs and sperm from adult salmon which had returned from the sea to spawn.

Watling and Hallard (1974) reported the only program whose development was funded by Title I of the Elementary Secondary Education Act. The program and its' associated field trip were designed especially for children with learning difficulties. These children used keys designed especially for nonreaders in order to identify the organism they found at the seashore.

Eyster (1975) conducts a six-week summer session dealing with the various aspects of the marine environment. The session includes guest speakers, field trips, experiences in map reading and journal use, paper writing, field investigations, and laboratory disections.

Reed (1973) describes the actually conduction of the day field trip in a program, whose curriculum guide was published by the National Park Service (see curriculum guide section). The field trip portion of the program is run by the National Park Service and not necessarily intended for a specific grade level. The trip begins with a 40 minute boat ride, during which the students take water samples. Upon arrival at their destination, the students receive a tour and introduction to the nautical aspects of a converted Coast Guard Lightship. Following the tour, water analysis of the samples gathered by the students as well as other hands on activities are conducted in the ships laboratory.

Curriculum infusion programs are very much in evidence in the recent literature; let us briefly glance at several of these programs. Cockran's (1973) students, upon request from the project engineer of a runway extension project which was to extend into the intertidal zone, cataloged the area and based upon their findings, wrote environmental impact statements which were used by project personnel. Rutherford (1974) describes a hands on sea going operation in San Francisco Bay which involves students in chemistry, ichthology, geology, and invertebrate biology. Wood and

Bayl (1975), and Guy (1975) discuss seperate programs which culminate in several day field trips to Cape Hatteras where students have a chance to study various aspects of the marine environment. In the Cape Hatteras area there is ample opportunity to study longshore transport and to compare areas where this transport is allowed to proceed naturally with areas where the National Park Service has attempted to retard sand movement. Naquin (1975) presents a program quite similar to those of Guy and Wood and Bayly except that the field experience took place on Grand Isl., Mississippi and program development was originally precipitated by community pressure. Naquin'scommunity was one composed primarily of fishing families who realized that, "progress" had erased the biological value of the local estuarian environment. Farraday (1975) discusses a three day trip to Wallops Island, Virginia and the pretrip activities, which included, (1) a review study of the invertebrates, (2) discussions concerning the ecology of the seashore, (3) discussions about food chains and energy flow, (4) operation of a salt water acquarium, (5) disection of marine specimens, (6) the formulation of questions to be answered on the trip.

At least three authors reported marine science programs of a year's duration; these were Silverstein and Siegel (1975), Whitaker (1975), and Webb (1973)/. Webb describes an on going program which is conducted in 9 of 10 Palm Beach County, Florida high schools. Whitaker's program takes place in Warwick and Cranston, Rhode Island high schools while

Silverstein and Siegel's takes place at John Dewey High School in Brooklyn, N. Y. The Whitaker and Silverstein programs were developed with the aid of Title III monies of the Elementary Secondary Education Act. Admittance to courses in all three programs carry a prerequisite of basic biology. All three programs involve field work and the Whitaker program beyond providing shore sampling opportunities for the students, provides opportunities for the students to do some off shore sampling. When reading these papers, one is hard pressed not to become excited because of the enthusiasm shown by the authors for their individual programs.

The Florida Ocean Sciences Institute at Deerfield Beach conducts an on going program for school dropouts, Boyd (1973). The institute takes in youth age 14-18 of normal I. Q. who have at least a 6th grade reading level. The program is a vocational liberal arts program and demands that each student become knowledgeable in a number of areas during his 9 month stay. The program is run both ashore and at sea, where it offers experiences in rigging, charting, navigation, ships carpentry, drafting and blueprint reading, hydrographic surveying, plotting currents waves and tides, performing ecological pollution studies, collecting marine biological specimens, etc.

A review of the programs described above along with those not specifically cited, is provided in table 1 of the appendix.

Curriculum Guides. Curriculum guides usually offer something for everyone; however, as was previously mentioned, each guide must be carefully edited in order to ascertain its' applicability to a given area.

Between January 1973 and February 1976, thirteen of these guides were published. Interestingly, all of these guides were published by the Educational Resources Information Center (ERIC). Six of these guides were authored by:

Gary L. Awkerman
Charleston County School District
North Charleston, South Carolina

The development of all of Awkerman's guides was aided by Title III monies of the ESEA, and all were designed to be infused into an already existing program.

National Park Service (1974) guide is claimed by the author to be for the elementary school. This may be the case; however, if a high school group has not had long and varied experiences with the marine environment, then this guide is probally applicable for use with them.

Heitzmann (1975) has designed a program which is strongly founded in the area of social studies. There are however, units in this guide on fishing and naval technology which will fit easily into a good marine science program.

All of these guides are reviewed in table 2 of the appendix. In this table, the level of applicability for each guide was determined by this author after careful editing. The level assigned may not necessarily agree with the level assigned by the guide's author.

Summary

The literature provides ample evidence of increasing activity in marine science education at the precollege level. The majority of the activity reported during the 1973 through 1976 period took place from the Delaware coast south to Florida and along the west coast, especially in the state of California.

Program funding for development, when not taken care of by local sources, appears to be originating primarily from the Elementary Secondary Education Act and the National Sea Grant Act, To date, the Elementary Secondary Education Act has been the major contributor.

Currently, the primary program emphasis, in marine science education, envolves offering units of short duration infused into some other science course. At the present time, the offering of complete marine science courses seems to be an upper level affair in a few widely dispersed schools or school systems.

The current surge toward public enlightment and a new level of enviorommental awareness on the part of the nations youth, coupled with the availability of funds from various governmental sources, promises a bright future for marine science education at the precollege level.

References

Anson, Elva, Putting the zones and marine biology together. Instructor, 82(9): 85-86: May 1973.

Awkerman, Gary L., Sea changes, topics in marine earth sciences. ERIC ED 086 556: 1973.

_____, Animals of the sea: coelenterates, protozoa, and sponges. ERIC ED 086 552: 1974a.

_____, Aspects of marine ecology. ERIC ED 086 553: 1974b.

_____, Estuaries. ERIC ED 086 554: 1974c.

_____, Marine biological field techniques. ERIC ED 086 555: 1974d.

_____, Zones of life in the sea. ERIC ED 086 557: 1974e.

_____, Teller, P. F. and Laurie, Dan, Priorities in ocean schience study. Science Education, 58(4): 449-456: 1974f.

Baird, Gerald, Oceanography in a swimming pool. Science and Children, 11(7) 7-10: Apr. 1974.

Boyd, Ellsworth, Dive-in for dropouts. Oceans, 6(5): 54-55: Sept-Oct. 1973.

Brevard County School System, Man's impact on the environment: the estuary as an ecosystem. ERIC ED 106 077: 1975a.

_____, Man's impact on the environment: the barrier beach as an ecosystem. ERIC ED 106 076: 1975b.

Bruce, David S. and Linden, Donald G., Use of the marine vertebrate, the flounder, in the physiology teaching laboratory. American Biology Teacher, 35(8): 465-469: Nov. 1973.

Bryan, R. C., Campus ecology. Science Activities, 11(3): 29-31: July-Aug. 1974.

Campbell, J. A., Eco-chem. Journal of Chemical Education, 52(3): 171: Mar. 1975.

Castellani, Marylynn L. (ed), Guide to marine ecological research a curriculum for secondary students. ERIC ED 106 089: 1975.

Cleveland, Lois Jane, Family life salmon style. Instructor, 83(3): 112: Nov. 1973.

Cockran, Tom, Oregon students help prepare impact statements. American Biology Teacher, 35: 518-520: Dec. 1973.

Contra Costa County Department of Education, Marine ecology research resource units, grades 7-9. ERIC ED 106 088: 1975.

Donnelly, Dennis P., The atmosphere and the ocean: a field study course. American Journal of Physics, 41(5): 664-669: May 1973.

Earney, Fillmore C. F., Ocean space and seabed mining. Journal of Geography, 74(6): 539-547: Dec. 1975.

Eyster, Carol J., Oceanology. Science Teacher, 42(5): 52-53 May 1975.

Farraday, Clayton L., Precollege oceanography: short course in marine science for high school. American Biology Teacher, 37(8): 475-477: Nov. 1975.

Foster, Oma Ruth, Maryland environmental education survey. Part one: the cheasapeake bay as an integral part of the environmental education program. ERIC ED 107 475: 1975.

Gee, Maureen, Kits in Motion. Science and Children, 12(4): 31: Feb. 1973.

Gould, John A., Maine discovers the mussel. Down East, 22(3): 48-51: Oct. 1975.

Gregson, A., Biological assessment of river quality. School Science Review, 55(191): 295-298: Dec. 1973.

Guy, Diane, Cape hatteras national seashore field project. Science Teacher, 42(6): 28: June 1975.

Heitzmann, Wm. Ray, Two if by sea: america's maritime heritage and the social studies teacher. ERIC ED 109 039, 1975.

Hemenway, Leone, Please pass the plankton. Wilson Library Bulletin, 49(2): 165-173; Oct. 1974.

Hummer, Paul, Fish ponds-wources of orgainisms for the laboratory. Science Education, 41(5): 55-57; May 1974.

Kane, Michael M., An algae-outside purification system for marine aquaria. American Biology Teacher, 36(6): 344-345; 1974.

Knauss, John A., Marine science and the 1974 law of the sea conference. Science, 184(4144): 1335-1341; June 1974.

Lidstrom, Esther, The aquart room. Arts and Activities, 30-31; Dec. 1975.

Lynch, D. L. and Fenwich, M. G., Factors affecting the growth of two green algae. American Biology Teacher, 36(8): 494-495; 1974.

Marcus, Bernard A., A model for demonstrating algal blooms in artifical reservoirs. American Biology Teacher, 36(9): 558-560; 1974.

Marshall, Nelson, Oceanography, the new frontier for the twenty-first century. Science Teacher, 40(8): 16-19; Nov. 1973.

Mary, Charlotta, Adventures in ecological reading, language arts (experimental). ERIC ED 086 529; 1974.

Mathis, Philip M., The effect of sulfur dioxide on lichens: a field activity. American Biology Teacher, 36(7): 418-419; 1974.

McDougal, Christina (ed), UN and the sea. UNITAR news vol 16 no. 1. ERIC ED 104 662; 1975.

McFadden, D. L., Teaching in tide pools. Oceans, 6(5): 44-49; Sept-Oct. 1973.

Miller, John W. and Mazur, Jane E., Gallon-Jar marine aquaria. American Biology Teacher, 36: 40-41; Jan. 1974.

Minemier, Betty, The ocean world of Jacques Cousteau. Instructor, 84(7): 125; Mar. 1975.

Moutvic, J. C., Pickle jar oceanography. Science Teacher, 40: 43; Nov. 1973.

Morgan, Myra J., A bibliography of elementary and secondary marine science curriculum projects and education materials. ERIC ED 089 995; 1974.

Murphy, James E., Sex, symmetry and sea urchins. Science Activities, 9(3): 21-23; Apr. 1973.

_____, Seaweeds are much more than weeds. Science Activities, 11(3): 11-13; Jul-Aug. 1974.

Naquin, Nancy, Marine wetlands study. Science Teacher, 42(2): 41; 1975.

National Oceans and Atmospheric Administration, User;s guide to OASIS, oceanic and atmospheric scientific information system. Key to oceanic and atmospheric information sources no. 1. ERIC ED 095 932; 1975.

National Park Service, Elementary teacher's resource manual, lightship chesapeake 1973-4. ERIC ED 086 501: 1974.

Office of the President, The federal ocean program. ERIC ED 072 962; 1973.

Plikey, Orrin H., Let the lighthouse fall in. The High School Journal, 58(6): 1-10; Oct. 1974.

Postiglione, Ralph, Dancing mothballs and fish buoyancy. American Biology Teacher, 37(1): 49; 1975.

Reed, Judith, Operation lightship. Children Today, 2: 7-10; May 1973.

Rillo, Thomas J., Exploring oil pollition. Science Activities. LL: 52-27; May/June 1974.

Ring, Paul, Marine related films available from the university of maine film rental library. ERIC ED 095 023; 1974.

Rutherford, Robert, San Francisco bay studied. American Biology Teacher, 36(2): 110; 1974.

Schweitzer, James P., A bibliography of popular books on the marine environment and wetlands ecology. ERIC ED 067 230; 1973a.

_____, Directory of marine science education. ERIC ED 093 615; 1973b.

_____, Marine science education in america: it's status in precollege programs. Science Teacher, 40(8): 24-26; Nov. 1973c.

Science Teacher, Sea grant curriculum on the marine environment. Science Teacher, 42(2): 50-51; Feb. 1975.

Silverstein, Harold, and Siegel, Lou, 45 minutes from broadway an action approach to marine biology. American Biology Teacher, 37(7): 422-425; Oct. 1975.

Watling, Carol and Hallard, Raymond E., The sea beside us. Teaching the exceptional child, 7(1): 26-28; Fall 1974.

Webb, Helen S., All wet-palm beach county's marine science program. Contemporary Education, 44: 346-348; May 1973.

Whitaker, David M., Marine field study on the high school level. American Biology Teacher, 37 (4): 240-241; Apr. 1975.

Wood, John H. and Bayly, Maxine M., Field trip studies on cape hatteras. Science Teacher, 42(4): 23-25; Apr. 1975.

Wright, Kirk E., Preserving radulae patterns of limpets. American Biology Teacher, 37(5): 300; May 1975.

Appendix

Key

An "X" was placed in a box when it was reasonably clear from the paper that the program element in question was part of the program. An absence in a box does not necessarily mean that the program did not consider this area. The absence does; however, indicate that based upon the information presented, it was not entirely clear that the program considered the element in question. An "X" in the bibliography category indicates that the published paper contained a bibliography.

Table 1

Program Element \ Study	Anson 1973	Baird 1974	Boyd 1973	Cleveland 1973
Level	Grade 5	Grade 5	High School	Grade 1
Field Trip + Length	Weekend	Approx. 2 Hrs.	X	One Day
Laboratory			X	
Program Type	Infusion	Infusion	Full Time	Infusion
Career Education			X	
Considers Values	X		X	X
Botany	X		X	
Invertebrate Zoology	X		X	
Maine Ecology	X		X	X
Ichthology			X	X
Life Cycles			X	X
Marine Chemistry	X	X	X	
Physical Oceanography	X	X	X	
Weather			X	
Species Identification	X		X	X
Non-science Subjects			X	X
Funding Source	Not Given	Not Given	Not Given	Not Given
Bibliography				

Table 1 Continued

Cockran 1973	Donnelly 1973	Eyster 1975	Farraday 1975	Gee 1975
High School	Applicable to H.S.	Junior High	High School	K-9
X	X	One Day	3 Days	
	X	X	X	X
Infusion	Depends on School	Summer	Infusion	Infusion
X		X		
X			X	X
X		X	X	
X		X	X	
X		X	X	X
				X
		X	X	X
			X	X
	X		X	X
	X			
X		X	X	X
Not Given	Not Given	Not Given	Not Given	Not Given

Table 1 Continued

Guy 1975	Lidstrom 1975	McFadden 1973	Naquin 1975	Reed 1973
High School	Elementary	Elementary Jr. H. S. + H. S.	High School	K-12
One Week		X	3 Days	One Day
		X		X
Infusion	Infusion	Infusion	Year Long	Infusion
		X	X	X
X		X	X	X
X		X	X	X
X		X	X	X
X	X	X	X	X
X		X	X	
X		X	X	X
X		X	X	X
X	X	X	X	X
		X		X
X		X	X	
	X			
Not Given	Not Given	Not Given	Not Given	National Pk. Service

Table 1 Continued

Rutherford 1974	Science Teacher 1975	Silverstein + Siegel 1975	Watling + Hallard 1974	Webb 1973
High School	K-12	High School	Elementary Jr. H. S.	High School
X	Depends on School	X	Over Night	X
X	Depends on School	X		X
Infusion	Depnds on School	Year Long	Infusion	Year Long
	X	X		
	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X	X	X
X	X	X		X
X	X	X	X	X
X	X	X		X
X	X	X	X	X
	X			
X	X	X	X	X
	X			
Not Given	National Sea Grant	Title III ESEA	Title I ESEA	Not Given

Table 1 Continued

Whitaker 1975	Wood & Bayly 1975
High School	High School
X	3 Days
X	
Full Year	Infusion
X	
X	X
X	X
X	X
X	X
X	
X	X
X	X
X	X
X	X
Title III ESEA	Not Given
	X

Table 2

Program Element \ Study	Awkerman ED 086 552	Awkerman ED 086 553	Awkerman ED 086 554	Awkerman ED 086 555
Level	K-12	K-12	K-12	K-12
Field Trip & Length				One Day
Laboratory		X	X	X
Program Type	Infusion	Infusion	Infusion	Infusion
Career Education	X		X	
Considers Values	X		X	
Botany		X	X	X
Invertebrate Zoology	X	X	X	X
Marine Ecology	X	X	X	X
Ichthology		X		
Life Cycles	X	X		
Marine Chemistry		X	X	X
Physical Oceanography		X	X	X
Weather				
Species Identification	X		X	X
Non-science Subjects				
Funding Source	Title III ESEA	Title III ESEA	Title III ESEA	Title III ESEA
Bibliography		X	X	X

Table 2 Continued

Awkerman ED 086 556	Awkerman ED 086 557	Brevard Co. School Dist. ED 106 076	Brevard Co. School Dist. ED 106 077	Castellani 1975
K-12	K-12	K-12	K-12	K-12
	One Day			X
	X			X
Infusion	Infusion	Infusion	Infusion	Infusion
		X	X	
X				
	X			
	X	X	X	X
	X			X
	X			X
		X	X	X
X	X	X	X	X
X	X			
	X			X
Title III ESEA	Title III ESEA	Title III ESEA	Title III ESEA	Title III ESEA
		X	X	

Table 2 Continued

Contra Costa Co. Schools 1975	Heitzmann 1975	Mary 1974	National Pk. Service 1974
K-12	K-12	Jr. HS & SR.HS.	K-12
At Least 4 Hours	X		One Day
X			X
Infusion	Infusion	Infusion	Infusion
	X	X	X
			X
X		X	
X	X	X	
X		X	X
X		X	
X		X	
X		X	X
X		X	X
X		X	X
X		X	
	X		X
Not Given	Not Given	Not Given	National Pk. Service
X	X	X	